Mathematical model illustrates our online 'copycat' behavior

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Researchers from the University of Oxford, the University of Limerick, and the Harvard School of Public Health have developed a mathematical model to examine online social networks, in particular the trade-off between copying our friends and relying on 'best-seller' lists.

The researchers examined how users are influenced in the choice of apps that they install on their Facebook pages by creating a mathematical model to capture the dynamics at play. By incorporating data from the installation of Facebook apps into their mathematical model, they found that users selected apps on the basis of recent adoptions by their friends rather than by using Facebook's equivalent of a best-seller list of apps. The model suggests users tended to be swayed by recent activity—from their `friends' on Facebook—that they saw on their Facebook feeds over the previous couple of days. The research, published in the journal, *Proceedings of the National Academy of Sciences*, finds that the "copycat" tendency in human behaviour is strong and that we can be influenced by the activities of others over a relatively short period of time.

The mathematical model examined data from an empirical study published in 2010, which had tracked 100 million installations of apps adopted by Facebook users during two months. In the 2010 study, based on data collected in 2007, all Facebook users were able to see a list of the most popular apps (similar to best-seller lists) on their pages, as well as being notified about their friends' recent app installations. In the 2010 study (which included two of the authors of the new study), researchers

found that in some cases, a user's decision to install some apps seemed virtually unaffected by the activities of others, whereas sometimes they were strongly affected by the behaviour of others – even though the apps in these two categories did not appear to be distinguished by any particular characteristics. Instead, once an app reached some popularity threshold (as measured by the installation rate), its popularity tended to rise to stellar proportions.

In the new study, the researchers developed a mathematical model to distinguish between the consequences of two distinct, competing mechanisms that appeared to drive the dynamics behind the behaviour of the Facebook users. Using their model and extensive computer simulations, they looked behind the empirical data to see whether Facebook users' behaviour could be modelled as being influenced primarily by the notifications of apps recently installed on their friends' Facebook pages or mainly driven by which apps appeared on the best-seller list. Using the supercomputers of the Irish Centre for High-End Computing (ICHEC), the researchers ran thousands of simulations in which they varied the relative dominance of the two influences (recent installations versus cumulative popularity). It took the researchers 15,000 hours of computer processing to best match the results of the simulations with the characteristics of app installation that were observed in the earlier empirical study.

The researchers found that, although users seem to be influenced by both, the stronger effect on popularity dynamics was caused by the recent behaviour of others. The best-seller list did have a 'mild' effect on the behaviour of Facebook users, but an instinct to copy the behaviour of others was by far the more dominant instinct.

Associate Professor Felix Reed-Tsochas, James Martin Lecturer in Complex Systems at the Said Business School and Director of Complexity Economics at the Institute for New Economic Thinking at

the University of Oxford, said: 'We have used sophisticated modelling techniques to show how it is possible to tease apart different causal mechanisms that underpin behaviour even when the empirical data are purely observational. This is significant because the assumption these days is that only experimental research designs can provide such answers. Here, we found that the "copycat" tendency plays a very important role in online behaviour. This might be because users need to make quick decisions in information-rich environments, but other research has identified similar imitative behaviour in the off-line world.'

Professor James Gleeson, from the Department of Mathematics and Statistics at the University of Limerick, said: 'This study reveals how we can explore different scenarios using mathematical models to disentangle what drives people to behave the way they do using large data sets from the real online world. This opens up lots of new possibilities for studying human behaviour.'

Commenting on the significance of the method behind the study, Associate Professor Mason Porter, from the Mathematical Institute at University of Oxford, said: 'We hope that our paper can help serve as a guide for modelling complex systems and how data can be incorporated directly into such modelling efforts. The importance of mathematical modelling often seems to be lost amidst the overabundance of empirical studies, and I cannot stress enough that mathematics is also crucial to help illustrate how things work.'

More information: A simple generative model of collective online behavior, by James P Gleeson. Davide Cellai, Jukka-Pekka Onnela, Mason A Porter and Felix Reed-Tsochas, *Proceedings of the National Academy of Sciences*, www.pnas.org/cgi/doi/10.1073/pnas.1313895111

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